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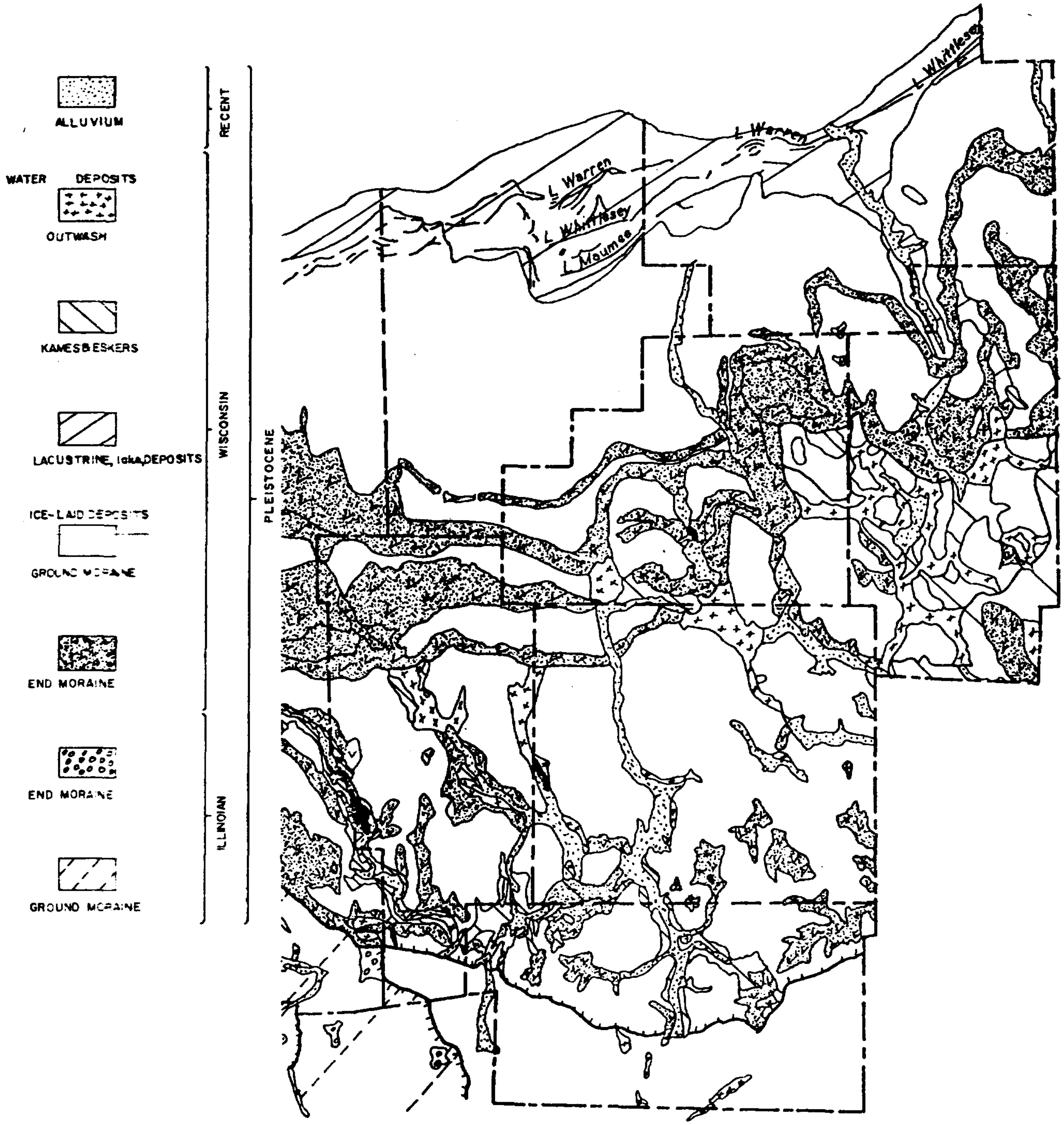

FIGURE . Map of northeastern Ohio showing distribution of Quaternary deposits (modified from Goldthwait et al., 1961).

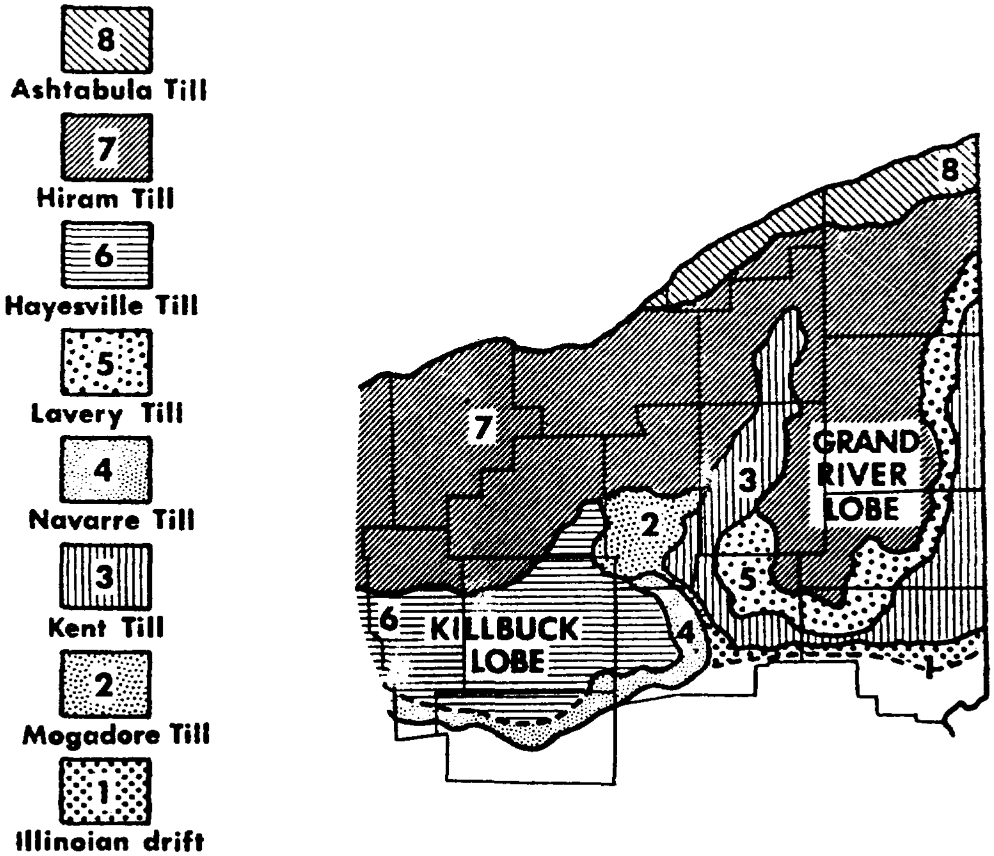

FIGURE 2. Map of northeastern Ohio showing surface distribution of Illinoian drift and Wisconsin till units (Modified from White, 1967.)

At the pit of the Ravenna Sand and Gravel Company, about 1/4 mile south of State Route 5, on New Milford Road, Ravenna Township (Fig. 9), in Portage County, as much as 50 feet of Illinoian drift is exposed (Winslow and White, 1966). The lowest unit of the drift is a brown, calcareous, sandy clay till that is exposed in the floor of the pit, near its east end. The till contains an abundance of boulders, some of which are over one foot in diameter. Many of the boulders are striated and faceted as the result of abrasion while embedded in the base of the ice.

Overlying the till is 25-30 feet of gray gravel and brown sand, conspicuously cross-bedded in cut and fill structures. The high percentage of carbonate pebbles (32% limestone and dolostone) and crystalline rock fragments (23%), compare favorably with similar percentages found in Illinoian gravels at localities in Cuyahoga and Geauga counties (Winslow and White, 1966). A brown colored, thin, silty to sandy textured, oxidized till, as much as three feet thick, was formerly exposed in the pit, above the gravel and below a gray, coarse textured, calcareous, Wisconsin (Mogadore) till. The stratified sand and gravel between the two Illinoian till sheets may indicate an episode of ice retreat within the Illinoian stage of glaciation (Winslow and White, 1966).

SANGAMON

Physical evidence for the Sangamon interglacial stage is poorly preserved in the guidebook area. Erosion during the subsequent Wisconsin glacial stage probably removed much of the record. The weathered zones in Illinoian drift at the Garfield Heights and Ravenna Sand and Gravel Company Pits were developed during this interval. Fossil gastropods reported from the Sangamon soil at the Garfield Heights pit (Leonard, 1953) consist of several species which now reach the southern limits of their range far to the north in Canada. The fact that they were able to live in Ohio during the Sangamon suggests that summers were cooler than those now occurring in this area.

WISCONSIN

The Wisconsin ice advancing into northeastern Ohio was split into two lobes as a result of topography. The western segment, the Killbuck Lobe, moved southeast down the low area between the high land in Richland County and the Summit-Geauga County upland. To the east of the Summit-Geauga high land, the Grand River lobe advanced southward through the Grand River lowland (White, 1967). The location of these lobes is shown in Fig. 2.

The Wisconsin ice underwent a number of fluctuations in which the ice terminus retreated varying distances to the north. At least five re-advances of the ice are recorded in northeastern Ohio by till sheets of distinctive lithology (Fig. 2; Table 1).

In general, the age of the surface drift exposed at a given location in the guidebook area can be determined by comparison with Fig. 2 and Table 1. Exposures in some deeper gravel pits, strip mines, and stream valleys, however, may contain several superimposed drift sheets. The proper identification of these multiple till sheets usually requires mechanical analysis of the sand-silt-clay ratios and careful measurements of the depth of oxidation and leaching.

TABLE 1 — *Properties of Wisconsin age glacial deposits in northeastern Ohio. (Based on data published in White, 1960, 1961, 1967; DeLong and White, 1963; Winslow and White, 1966; Goldthwait, et al., 1961.)*

LOBE	UNIT	LITHOLOGIC TYPE	COMPOSITION, %			THICKNESS	OXIDIZED COLOR	DEPTH OF WEATHERING	
			SAND	SILT	CLAY			OXIDIZED and LEACHED	OXIDIZED
GRAND RIVER LOBE	ASHTABULA TILL	Silty clay till	23	48	29	0 – 50'+	Brown	3' 11"	5' 9"
	HIRAM TILL	Clay till	12	41	47	0 – 30'+	Dark brown	3'	12'
	LAVERY TILL	Silty clay till	24	45	31	0 – 15'	Dark brown	4' 7"	12' 7"
	KENT TILL	Silty sandy till	31	46	23	0 – 100'+	Yellow brown	5' 8"	10' 1"
	MOGADORE TILL	Sandy till	46	43	11	0 – 90'	Yellow- to olive-brown	7' 4"	12' 2"
KILLBUCK LOBE	ASHTABULA TILL	Silty clay till	?	?	?	0 – 20'	Brown	1' 5"	11"
	HIRAM TILL	Clay till	26	46	28	0 – 12'	Dark brown	2' 9"	4' 6"+
	HAYESVILLE TILL	Silty clay till	26	46	28	0 – 12'	Dark brown	3' 11"	2' 10"
	NAVARRE TILL	Silty sandy till	47	37	16	0 – 15'+	Yellow brown	5' 1"	3' 8"
	MILLBROOK TILL (ILLINOIAN?)	Sandy till	43	42	15	0 – 21'	Yellow- to olive-brown	9' 3"	13' 9"

Short intermittent retreats of the ice to the north during the Wisconsin glacial stage permitted re-establishment of normal surface drainage in the area. Some of the northward flowing streams were dammed by the ice terminus and/or moraines left in the valleys by the retreating ice. Water was ponded behind these dams, forming a number of different lakes that waxed and waned with the fluctuations of the ice terminus. Lake sediments deposited in these lakes can be seen along the valleys of many of the streams that drain north into Lake Erie. Although the presence of these deposits has been known for 80 years (Claypole, 1887), they have not been carefully studied. They are all probably Wisconsin in age, but their exact placement in the sequence of Wisconsin Age events is not known.

Fluctuations of the ice margin are also recorded in the guidebook area by deposits of wind-blown silt, or loess. Withdrawal of the ice left large areas of drift exposed at the surface without a cover of vegetation. The wind picked up the finer materials from the drift and re-deposited it as loess. Loess has been reported from below Wisconsin tills of different ages in northeastern Ohio (White and Totten, 1967). At Garfield Heights, in Cuyahoga County (Fig. 8), as much as 9 feet of silt (loess?) rests on a buried Sangamon soil and in turn is covered by lake sediments and the Hiram Till. Twenty species of snails have been reported from this deposit by Leonard (1953). The upper portion of this loess sequence has been dated by radiocarbon at 28,195 ± 535 years (White, 1965). The lower portion of the immediately overlying laminated silts (varves?) contains degraded plant fragments, insects (Coope, 1968; White, 1968) and mollusks. Wood from this unit has been dated at 24,600 ± 800 and 23,313 ± 391 years before the present (White, 1968).

ANCESTRAL GREAT LAKES

The last Wisconsin ice, represented by the Ashtabula Till (Fig. 2), withdrew from northeastern Ohio between 14,000 and 15,000 years ago. The present Great Lakes started their rather complex history about this period of time. Fluctuations in the water levels in these predecessors of the modern Great Lakes were controlled by oscillations in the margin of the late Wisconsin ice lobes; downcutting of some lake outlets by stream erosion; and regional crustal uplift due to the removal of the thick load of glacial ice. Most of the former lake levels in the Erie Basin are recorded in a series of beach ridges which occur above the present level of Lake Erie (Table 2; Fig. 1). Frank Carney mapped these features during the early part of the 20th century. Although these maps were never published, copies can still be purchased from the Ohio Geological Survey.

TABLE 2

Sequence of lake stages in the Erie Basin (modified from White, 1965)

Years before present	Lake stage	Elev. of shore
0	Erie	572'
6,000	low water	570' (?)
10,000	Lundy	620'
	Elkton	640'
	Warren III	675'
	Wayne	660'
12,000	Warren II	680'
	Warren I	690'
13,000	Whittlesey	735'
	Arkona	695', 700', 710'
14,000	Maumee III	785'
	Maumee II	760'
	Maumee I	790'

TABLE 1 - LOW-FLOW FREQUENCY INDICES

Station No. State	Station No. USGS	Station Name	Location	Drainage area in sq mi	Period of record water years	Mean Annual Discharge 1931-60 cfs	Mean Annual Discharge 1931-60 mgd/sq mi	Discharge Exceeded 90% of Time cfs	Discharge Exceeded 90% of Time Ratio * to mean annual discharge	2-Year Frequency 7-Day Duration Average Low-Flow Discharge cfs	2-Year Frequency 7-Day Duration Average Low-Flow Discharge mgd/sq mi	2-Year Frequency 7-Day Duration Average Low-Flow Discharge Ratio ** to mean annual discharge
		STREAMS TRIBUTARY TO LAKE ERIE (Continued)										
38.2	4-1942	Toussaint Creek near Limestone	Lat 41°32'55", long 83°14'30", at highway bridge 1-1/4 miles west of Limestone, Ottawa County.	74.7	b1959-63	c48.4	.419	d.95	.0196	d.68	.00502	.0120
39	4-1945	Portage River near Pemberville	Lat 41°22'45", long 83°28'35", at highway bridge 2-1/2 miles southwest of Pemberville, Wood County.	334	1931-35	a236	.457	a2.30	.00975	a1.40	.00271	.00593
40	4-1950	North Branch Portage River near Bowling Green	Lat 41°23'20", long 83°33'40", at highway bridge 5 miles northeast of Bowling Green, Wood County.	54.0	1928-32	a38.9	.466	a.67	.0172	a.40	.00479	.0103
41	4-1955	Portage River at Woodville	Lat 41°26'55", long 83°21'41", at bridge on U. S. Highway 20 in Woodville, Sandusky County.	433	1929-35; 1940-63	a307	.458	a4.75	.0155	e2.76	.00412	.00899
42	4-1960	Sandusky River near Bucyrus	Lat 40°48'13", long 83°00'21", at highway bridge 1-1/2 miles west of Bucyrus, Crawford County, and 12 miles below Loss Creek.	89.8	1926-35; 1939-51	a77.4	0.557	a2.10	0.0271	e1.80	0.0130	0.0233
43	4-1965	Sandusky River near Upper Sandusky	Lat 40°51'02", long 83°15'23", at highway bridge 3/4 mile above Rock Run and 2 miles northeast of Upper Sandusky, Wyandot County.	299	1922-35; 1939-63	a236	.510	a6.40	.0271	e4.20	.00908	.0178
45	4-1970	Sandusky River near Mexico	Lat 41°02'39", long 83°11'42", at highway bridge 3 miles above Honey Creek and 4-1/4 miles north of Mexico, Seneca County.	776	1924-35; 1939-63	a557	.464	a20.5	.0368	e13.5	.0112	.0242
47	4-1980	Sandusky River near Fremont	Lat 41°18'28", long 83°09'32", at highway bridge 2.3 miles above Ballville power dam, 2-1/2 miles below Wolf Creek and 3-1/2 miles southwest of Fremont, Sandusky County.	1,248	1924-35; 1939-63	a916	.474	a31.0	.0338	e22.0	.0114	.0240
47.3	4-1980.1	Green Creek near Fremont	Lat 41°23'30", long 83°01'45", at bridge on U. S. Highway 6, 5 miles northeast of Fremont, Sandusky County.	81.5	b1959, 1961-63	c63.6	.504	d14.5	.228	d14.1	.112	.222
47.5	4-1980.2	West Branch Huron River near Monroeville	Lat 41°16'40", long 82°40'30", at highway bridge on Lamoreaux Road, 2-1/2 miles northeast of Monroeville, Huron County, and 2-1/2 miles above mouth.	226	b1960-63	c188	.538	d9.20	.0489	d6.70	.0192	.0356
50	4-1990	Huron River at Milan	Lat 41°18'00", long 82°36'30", 500 ft below bridge on U. S. Highway 250, 1/4 mile northwest of Milan, Erie County, and 2 miles below confluence of East and West Branches.	363	1951-63	a297	.529	a14.0	.0471	a10.2	.0182	.0343
51	4-1995	Vermilion River near Vermilion	Lat 41°22'55", long 82°19'00", at bridge on North Ridge Road in Lorain County, 3-1/2 miles southeast of Vermilion, Erie County, and 4-1/2 miles above mouth.	260	1951-63	a238	.592	a4.00	.0168	a2.38	.00592	.0100
52	4-2000	East Branch Black River at Elyria	Lat 41°20'51", long 82°05'40", at Fuller Street Bridge, 1-1/4 miles southeast of center of Elyria, Lorain County, and 3 miles above junction with West Branch.	211	1923-35	a174	.533	a1.87	.0107	a1.01	.00309	.00580
55.9	4-2014	West Branch Rocky River at West View	Lat 41°21'00", long 81°54'15", at bridge on State Highway 252, at West View, on Cuyahoga-Lorain County line.	148	b1951, 1960 1962-63	c132	.576	d3.10	.0235	d2.00	.00873	.0152
56	4-2015	Rocky River near Berea	Lat 41°24'22", long 81°53'13", at highway bridge just below confluence of East and West Branches, 3 miles northwest of Berea, Cuyahoga County.	269	1924-35; 1944-63	a244	.586	a6.40	.0262	e4.17	.0100	.0171
67.5	4-2072	Tinkers Creek at Bedford	Lat 41°23'05", long 81°31'40", at bridge on State Highway 14, in Bedford, Cuyahoga County, 5.5 miles above mouth.	85.6	b1948, 1962-63	c101	.763	d7.60	.0752	d6.05	.0457	.0599
71	4-2090	Chagrin River at Willoughby	Lat 41°37'51", long 81°24'13", on left bank at city waterworks, 150 ft below waterworks dam, 800 ft below East Branch, 1 mile southeast of Willoughby, Lake County, and 5 miles above mouth.	251	1926-35; 1940-63	a313	.806	a32.5	.104	e25.0	.0644	.0799
72	4-2095	Grand River near North Bristol	Lat 41°24'45", long 80°54'45", at highway bridge 1/8 mile below Center Creek and 2-1/2 miles west of North Bristol, Trumbull County.	89.7	1943-47	a93.2	.672	a3.85	.0413	a2.72	.0196	.0292
73	4-2100	Phelps Creek near Windsor	Lat 41°30'55", long 80°56'05", at bridge on State Highway 534, 1.4 miles south of Windsor, Ashtabula County, and 1-1/2 miles above mouth.	26.4	1943-58	a32.3	.791	a.72	.0223	a.46	.0113	.0142
75	4-2105	Grand River near Rome	Lat 41°36'20", long 80°53'40", at bridge on U. S. Highway 6, 2-1/4 miles above Mud Creek and 2-1/2 miles west of Rome, Ashtabula County.	276	1943-47	a283	.663	a9.00	.0318	a6.10	.0143	.0216
78	4-2120	Grand River near Madison	Lat 41°44'26", long 81°02'48", at bridge on State Highway 528, 1/2 mile above Griswold Creek and 2 miles south of Madison, Lake County.	587	1923-35; 1939-63	a648	.707	a10.0	.0156	e5.19	.00571	.00808
80	4-2130	Conneaut Creek at Conneaut	Lat 41°55'34", long 80°36'18", at highway bridge at Conneaut, Ashtabula County, and 6-1/2 miles above mouth.	176	1923-35; 1951-63	a229	.831	a7.70	.0336	e3.90	.0142	.0170

LOW FLOW FREQUENCY AND STORAGE
REQUIREMENT INDICES
FOR OHIO STREAMS

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